Chapter 6 Army Use of Commercial/Civil SATCOM

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The Army is actively involved with DoD and the commercial SATCOM industry in identifying current and emerging technologies that can be leveraged to support the Army's goal of full-spectrum dominance.

OVERVIEW

The warfighter will always require the ability to communicate over Department of Defense (DoD) satellite systems. The combination of an evolving tactical doctrine with battlefield modernization ultimately results in a need for a tremendous increase in satellite communications capability. The Army's tactical warfighting concept has grown to encompass a much larger, more dispersed battlefield with communications required to pass large databases between all echelons of command. The Army will not necessarily own all the land interconnecting the warfighting enclaves. The shifting of forces and their geographical positions on the battlefield necessitates the use of satellite communications to effectively fight and win battles. The Army is actively involved with DoD and the commercial Satellite Communications (SATCOM) industry in identifying current and emerging technologies that can be leveraged to support the Army's goal of full-spectrum dominance. The Army also relies heavily on the use of the Global Positioning System (GPS), which is an example of a civil satellite system. Civil satellites are government, non-military space systems. They differ from commercial satellites in that civil satellites are designed and used primarily for the benefit of science, or to provide a public service, rather than for commercial profit-making business. This distinction is worth noting because the terms "civil" and "commercial" are sometimes incorrectly used interchangeably in the media's reporting about the space industry.

As discussed in chapter 3, Army SATCOM Requirements, the most critical communications in hostile threat environments (which are hard core communications requirements) require that assured access and protection be afforded by military SATCOM systems. However, there are many requirements, such as administrative and logistics traffic, that could be satisfied more flexibly and economically by commercial means. As demonstrated in recent Army operations as well as in wargames conducted by DoD, commercial satellites provide real benefits for the warfighter. Commercial satellites, however, have limitations that must be mitigated by careful planning. These factors must be weighed carefully against the communications requirements prior to selecting the commercial solution.

The Migration to Commercial SATCOM

The pace of technology development has outstripped almost everyone's expectations. For instance, the onboard payload power in commercial satellites has increased fourfold in less than ten years. This incredible progress is being helped along by breakthroughs in other areas, such as computing, where operating speeds are doubling about every 18 months. This translates to better, faster, and cheaper satellite services. These fast-developing technologies are affecting the military and DoD is making investments in the commercial world.

The rapid product cycle that the commercial industry can generate is a fact that DoD can rely upon and leverage to upgrade military battlefield systems. Not long ago, relying on the commercial SATCOM industry for military communications would have seemed unrealistic, if not risky. The daunting requirements of "military specifications" meant that the DoD could not turn to commercial industry to guarantee national security. These military specifications (more affectionately known as MILSPECs) were important and were designed to protect SATCOM assets from jamming and other threats pervasive throughout the Cold War era. Commercial SATCOM providers did not have to deal with MILSPECs nor were they particularly willing to get involved with the complexities and intrusiveness of the Federal Acquisition Regulations.

Commercial SATCOM providers can often satisfy the level of DoD service required at a much lower cost.

Today, it is actually appropriate that the military capitalize on commercial development because much of the commercial technology originated from DoD development efforts. Many of the proposed commercial SATCOM systems under development now, such as Spaceway and Teledesic, will employ the technology developed for the Milstar constellation, such as onboard processing, crosslinks, advanced antennas, and high-power systems. All military applications that can be supported by commercial satellites are being considered for that means of transport. Unencumbered by the costly demands of MILSPECs, commercial SATCOM providers can often satisfy the level of DoD service required at a much lower cost. These providers are going a bit further by making it easier for DoD to take a closer look by bringing their systems closer to military specifications whenever it is practical.

There are three main ways for the military to tap into the commercial SATCOM market. The first method is to insert commercial technology into a system that has military-unique requirements. Global Broadcast Service (GBS) is a good example of this. Despite its many military-unique features, GBS relies on commercial technology including the use of commercial software.

Secondly, the military can exploit commercial technology using commercial-off-the-shelf (COTS) equipment. Companies are manufacturing their products in such a way that the military can buy these types of systems. In fact, many commercial and military products are coming off the same assembly lines generating economies of scale that bring costs down even further.

Finally, the leasing or purchasing of commercial services can afford the warfighter much faster access to advanced capabilities and services than can the slower, more traditional government research, development, and acquisition cycle.

Today, the DoD leases 16 transponders on commercial satellites, providing a total of 941 MHz of commercial satellite capacity. These totals will continue to grow as demand grows.

MILITARY VS. COMMERCIAL SATELLITE SYSTEMS

Military SATCOM

There are distinct differences between military and commercial satellite systems. Military satellite systems such as Ultra High Frequency (UHF) Follow on, Defense Satellite Communications System, and Milstar are designed for use in war. They have features that provide jam resistance using spread spectrum techniques. This reduces capacity because anti-jamming methods reduce a system's spectrum usage efficiency. Radiation hardening and survivability enhancements on the satellites cost more and can cause reduced performance. There are specific characteristics that must be built into military satellite systems that can result in both increased cost and reduced capacity, adding to the need to prioritize users.

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Although DoD satellites provide coverage to most of the world, they do not cover some areas of the globe on a continuous basis. The north and south polar regions are not adequately covered by DoD satellites should Army forces require continuous capacity and connectivity in those areas. Today's Military Satellite Communications (MILSATCOM) systems are limited in their capacities to meet throughput requirements that warfighters need for communications on the move, paging, messaging, and broadcasting. Additionally, they are heavily oversubscribed. Access can be difficult. Particularly in Ultra High Frequency (UHF) and Super High Frequency, there can be a problem with frequency interference (unintentional or intentional) because of the heavy congestion of other SATCOM systems in these portions of the spectrum.

Military SATCOM systems have extremely limited surge capacity, and focusing support where it is needed is time consuming if a satellite must be moved to cover the area of operations. Reconfiguration of the SATCOM network requires planning and that takes time. This could cause disruption in current service and may not support the warfighter's need for fast, reliable, continuous communications.

Current DoD MILSATCOM systems have evolved over time. Some SATCOM ground terminals have been tailored to specific user communities resulting in limited interoperability between Services. In a joint warfighting scenario, this is a definite shortcoming. Finally, the cost of developing, acquiring, fielding, and maintaining a new MILSATCOM system is extremely expensive. In today's DoD downsizing environment, this fact severely limits serious consideration of any new DoD MILSATCOM systems.

Commercial SATCOM

Although commercial SATCOM resources have sometimes been touted as the answer to the increasing SATCOM requirements for the warfighter, there are many considerations involved.

It is true that commercial SATCOM providers are much more willing to accept military traffic over their satellites than they have been in the past. Competition has resulted in improved services between different providers and capacity continues to increase with each new commercial launch. That capacity diminishes, however, as more users are added to the systems. Using commercial SATCOM requires that military users must compete with civilians for access and those civilians may be adversaries. There is limited, if any, preemption for warfighters against other paying customers. Since control of access rests with a civilian firm, even if service is obtained, it could be terminated at militarily inconvenient times.

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Commercial satellites are built to withstand the rigors of space but not to the degree of military satellites. Although some jam resistance is obtainable, commercial SATCOM systems lack the beam nulling and signal processing capabilities that give the military systems the definite edge in extensive jam resistance. Although possible, it is unlikely that a potential jammer would attempt to jam a commercial SATCOM system. Politically, it would not be a smart move. If international communications are disrupted, the jammer nation would risk the displeasure of every user nation on the system in addition to the possibility of knocking out their own communications.

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The vulnerability of commercial SATCOM was made evident by the failure of the PanAmSat Galaxy IV satellite on 19 May 1998. The satellite lost proper attitude when both on-board computer systems inexplica-

Although SATCOM systems have costs associated with their use, it is transparent to the military user who does not see a "bill" for services rendered over DoD MILSATCOM systems.

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bly failed. The outage caused a huge wave of communications problems for many economic sectors in the U.S. including over 90 percent of U.S. pager customers. The loss of Galaxy IV literally affected millions of people. The reliance of the U.S. economy on this one satellite was completely underestimated and revealed how deeply ingrained SATCOM capabilities have become in daily life. There are more than 600 commercial, civil, and military satellites now in orbit with approximately 1,400 more to be launched in the next ten years. The impact of SATCOM on world commerce is, and will continue to be, phenomenal.

Although SATCOM systems have costs associated with their use, it is transparent to the military user who does not see a "bill" for services rendered over DoD MILSATCOM systems. Such is not the case with the use of commercial SATCOM systems. Steep costs are usually associated with the operation and use of commercial SATCOM systems and are normally billed directly to the user. An advantage of commercial SATCOM is that costs associated with system development, technological improvements, and launch costs have been borne and already capitalized by the commercial provider so that the Army's investment to use these systems is relatively small. Leased costs to use commercial SATCOM overseas, however, can run as much as 14 times what it would cost to use commercial SATCOM in the Continental United States (CONUS). Additionally, landing rights must be negotiated and paid to countries where SATCOM will be used by the U.S. forces.

The use of commercial SATCOM systems can involve additional approvals. For example, a common practice of host nations is to require host nation approval of "landing rights" for the operation of any foreign-owned satellite communication terminals within the host nation's borders. These are costs required to lease or acquire the ground terminals and a fee to use the space segment. A primary concern of many host nations is the loss of opportunity to capture revenue. Nations consider the privilege of transmitting from their soil to be a national resource. Potential revenue would be lost if foreign-owned satellite terminals were used without any payment of some form of tariff. Since transmission systems of the ministry of Post, Telegraph, and Telephone (PTT) of a host nation are bypassed whenever a satellite terminal is used, a license/approval to use that terminal is usually paid to the host nation's PTT ministry. Even though there can be prior agreements in place to operate SATCOM systems in a host nation, the cost of "landing rights" can be very high. Depending on the country, other requirements may also have to be met. For example, South Korea currently requires that all commercial satellite terminals operating in their country must belong to South Korea.

There are definite differences between the military satellite systems and the commercial satellite systems. Both have their advantages and disadvantages and both have their places within the Army satellite architecture.

HOW THE ARMY USES COMMERCIAL SATCOM

There are multiple layers of interoperability within a commercial communications system which make commercial SATCOM ideal for joint operations. With prior coordination of services, an Army Commander using an International Maritime Satellite (INMARSAT) terminal can easily talk to his Air Force counterpart anywhere in the world. This applies to communications with allied forces similarly equipped to use the same system. Finally, interoperability exists between military and commercial users of the same system.

The Army is already using commercial SATCOM extensively (INMARSAT and Iridium represent two of the better known systems). Commercial leases of C- and Ku-band capacity have long been accepted as part of the MILSATCOM system. Buying current commercial off-the-shelf technology is less expensive than funding the acquisition strategy necessary to procure military SATCOM equipment that is often obsolete before it is even fielded. The flexibility, accessibility, and availability of commercial SATCOM has definite advantages for the Army while tactical doctrine continues to evolve and contingency missions around the world demand a responsive communications capability.

Tactical applications for commercial satellites have been tested successfully during recent military operations around the world. U.S. peacekeeping forces in Bosnia and Hungary are currently using a commercial telecommunications system provided by Sprint Inc. (Herndon, VA) which provides voice and data access to local, worldwide long-distance, and internet services via SATCOM. Alascom transportable terminals, initially deployed to support training exercises in Alaska, were transferred to use in Panama during Operation Just Cause. PanAmSat, another commercial satellite system, has provided satellite links to the Army in support of drug interdiction programs in Bolivia and Peru. In Operation Desert Storm and Desert Shield, International Telecommunications Satellite Organization (INTELSAT) and INMARSAT were used extensively.

The flexibility and responsiveness of commercial SATCOM systems are characteristics that the Army covets when it comes to contingency operations. The commercial systems are in place, have available capacity, and are ready to be leased when needed. Finally, commercial SATCOM can be used by Army tactical units as a supplement to the existing MILSATCOM network. Just as the MILSATCOM network offers advantages that cannot be duplicated in a commercial SATCOM system, the reverse is also true. The Army has the option of using commercial assets when it does not necessarily require the specialized features offered by MILSATCOM in order to accomplish a mission.

Commercial SATCOM that leases available capacity allocates its resources to active paying customers. DoD MILSATCOM, on the other hand, is necessarily required to have a prioritization system. Tasks that might not be judged to have a high enough priority to use a DoD MILSATCOM system can be performed by the Army over commercial systems. Additionally, tasks that ARE high priority but which require more capacity than is available on a MILSATCOM system could be accommodated over commercial SATCOM.

Commercial SATCOM in Bosnia/Hungary

An excellent example of the cooperation between commercial communications service providers and the U.S. Army (also known as “C4/IT” community - Command, Control, Communications, Computers, and Information Technology) was demonstrated in early 1997 when Sprint, Inc. put together a tactical commercial communications network in Bosnia and Hungary. The system was designed and installed as a replacement for the Army’s tactical communication equipment and personnel

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DoD relies on several commercial satellite providers for imagery products and weather information. Landsat is a satellite system providing mapping products for tactical operations since 1972. DoD is also a large customer of the French satellite system Satellite Pour l'Observation de la Terre (SPOT) which purchases images for mission planning, terrain analysis, mapping and humanitarian missions.

supporting U.S. forces in the area of Kaposvar, Hungary. The reason for the replacement was to free up equipment and soldiers in the 5th Signal Command to prepare for another contingency operation.

SATCOM was part of an overall package of communications capabilities that provided soldiers voice and data access to local, worldwide long distance, and Internet services. These capabilities, in addition to satellite services, included microwave transmission systems, wireless/cellular voice and data systems, local and wide area network subsystems, switching equipment, and even backup generators needed to overcome power irregularities. Sprint, Inc. retains responsibility for the engineering, operation and maintenance of the entire system. In order to determine the ever-changing requirements for voice and data networks, Sprint personnel visit the sites they are supporting and report back the necessary changes required by the network.

This arrangement has worked well. With the commercial system in place and being actively used by soldiers in Bosnia, the Army is receiving services that are technologically mature and therefore more responsive than the older, military communications systems. Interoperability problems have been non-existent since one provider was used and coordination between various commercial companies was conducted well in advance of the actual changeover of systems.

Warfighter Concerns With Commercial SATCOM Systems

Unless DoD implements a Civil Reserve Air Fleet-like program for commercial SATCOM which would "reserve" the use of bandwidth and capacity in a national emergency, contingency access may be jeopardized, thus jeopardizing adequate DoD communications capability. This is particularly true in remote areas of the world or in areas where the existing communications infrastructure is severely degraded or destroyed. Getting a busy signal in a critical, time-sensitive situation is unacceptable.

The fact that commercial satellites offer little jamming resistance could pose a problem for the warfighter should a mission suddenly change from humanitarian to an adversarial conflict in which a jamming threat may materialize.

The "landing rights" costs associated with commercial SATCOM are another concern. As mentioned before, most nations impose tariff fees and other restrictions on the operation of any satellite terminal used in their country but not owned by them. Tariff fees can be very high, sometimes as much as $50,000 per terminal.

The technologies being developed for current and future commercial SATCOM systems are complex and require extensive testing. Information protocols might not match up exactly for military interoperability. The most significant example of this is the 288-satellite Teledesic constellation being touted as the "Internet in the Sky." The Teledesic effort is headed and financed by Bill Gates (Microsoft Chief Executive Officer) and Craig McCaw (McCaw Cellular). Teledesic has teamed with Motorola to design and build the satellites in this massive constellation. Teledesic will use its own proprietary transmission protocol rather than Asynchronous Transfer Mode (ATM) switching. The lack of ATM use does not preclude DoD use but will still require "tunneling," which is the necessary translation between the two protocols. This translation will reduce the system data throughput.

COMMERCIAL SATELLITE COMMUNICATIONS INITIATIVE

The Commercial Satellite Communications Initiative (CSCI) is a congressionally-mandated DoD program which is designed to provide non-mission essential SATCOM support to DoD users by leasing commercial transponders at a reduced cost. The program also provides pre-positioned surge capability for joint task force missions and introduces new information transfer services to the warfighter by using a phased integration of additional services and capabilities.

In partnership with the CSCI, Program Manager-Milsatcom established the Commercial SATCOM Terminal Program (CSTP) which essentially provides the ground terminals to support the contracts undertaken by the CSCI. The CSTP also seeks to develop and incorporate a fast, realistic, and flexible acquisition program that is similar to commercial practices. The program works closely with potential customers to determine exactly what equipment would best suit their requirements and then acquires the SATCOM equipment and logistical support for the customers.

The Defense Information Systems Agency engineers and coordinates all requests for commercial SATCOM for the CSCI on a fee-for-service basis. Costs will not exceed the U.S. tariff rate and, in most cases, will be 10-20 percent less than the current tariff rates. The costs for CSCI services are based upon several factors. These factors are transponder usage, use of the CSCI Bandwidth Management Center (BMC), terminals provided for the network, host nation approval negotiations, customer support engineering, systems engineering, and any other overhead costs. As part of its efforts to create a “one-stop SATCOM shop” at each of its Regional SATCOM Support Centers (RSSC), Army Space Command envisions that, in the future, the BMCs will be collocated with its RSSCs. The establishment of communications one-stop shops at the RSSCs is a specific goal stated in CJCSI 6250.01.

A DoD customer simply submits the communications requirements to the CSCI Management Office (CMO) which initiates the process of engineering a commercial SATCOM solution to meet the requirement. This includes providing the recommended commercial transponder capacity, BMC monitoring and control of SATCOM links, and recommendation of the proper ground terminals required to implement the network. All communications networks are designed to seamlessly interface with the Defense Information Systems Network (DISN). Additional information on acquiring commercial services through CSCI can be found in Chapter 7, SATCOM Planning, Access, and Control.

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CSCI Offers Three Types of Service

The phased approach used for the CSCI focuses on three types of commercial services.

The phased approach used for the CSCI focuses on transponder services, teleport services, and end-to-end transmission services.

Transponder services involve the leasing of transponders on commercial satellites which will provide the warfighter with bandwidth supporting high data rates. This phase is geared toward customers who already have a satellite ground terminal and are looking to reduce space segment costs.

Teleport services extend communications by providing access points at key locations into high-volume areas such as CONUS for customers who have overseas terminals.

The transponders available to the CSCI program include domestic and international transponders in both the C-band and Ku-band.

In February 2000, Hughes Global Services was awarded a second contract by GSA to provide DoD customers a wide variety of SATCOM services. It was designed to provide "one stop shopping" for government agencies requiring SATCOM. To date, more than 40 federal agencies as well as the Armed Forces and DoD have ordered services under the program. A key feature of the contract is the ability for government users to deal directly with Hughes Global Services. More information on the GSA-HGS contract can be obtained at www.hughesglobal.com.

End-to-end transmission services, which would provide all equipment and bandwidth needed to support the customer requirement for SATCOM, include terminals, satellite capacity, tail circuits, and interface equipment.

CSCI Satellite Transponders

The CMO assists customers in the selection of the right frequency band based on several factors. The mission and application which requires SATCOM support, the geographic distribution of users, available satellite coverage, and the availability of shared transponder capacity are all factors that are considered. Host nation approval considerations also are taken into account.

Full and partial transponders with global coverage can be leased for essentially any specified term. Recurring costs for using the transponders vary with the requirements for bandwidth, power, frequency, and any special features such as use of a spot beam or wide area beam. Nonrecurring costs include connections, setup, and equipment calibration.

The transponders available to the CSCI program include domestic and international transponders in both the C-band and Ku-band. C-band usage gives lower costs and wider coverage than Ku-band, but C-band requires larger ground terminals. Additionally, C-band usage can cause interference with terrestrial systems and may be difficult to license.

Teleport Services

The CSCI program offers customers who have SATCOM terminals overseas a means to extend service through an access point into high volume areas such as CONUS. Such access points are fixed facilities. Two such facilities are DISN gateway terminals and the DISN trunk terminals. Both have different missions and capabilities.

The DISN gateway terminals, with antennas that are almost eleven meters in diameter, act as dedicated network gateways supporting major switching centers, operations centers, and key functional centers. Data rates up to 44.736 Mbps can be supported as well as a maximum of 48 carriers and up to 16 independent channels. Both C- and Ku-band versions are available to customers.

DISN trunk terminals have three different sizes of antennas supporting different data rates. The 2.4-meter antenna supports up to four channels; an intermediate-sized 4.5-meter antenna supports up to eight channels; and the standard-sized 6 to 7-meter antenna supports up to 16 channels. Trunk terminals with these types of antennas are fully interoperable with the gateway terminals and are available in C- and Ku- band versions. Trunk terminals differ from gateway terminals by supporting much smaller network gateways as indicated by the size of their antennas.

In addition to these larger fixed-type terminals, the CSCI program can provide customers with smaller Very Small Aperture Terminal (VSAT) terminals supporting mesh and star-type. Such terminals are available to provide voice, data, facsimile, and Secure Telephone Unit (STU-III) services for disadvantaged users. With a mesh VSAT terminal, up to eight channels can be supported at up to 64 kbps each. Demand Assigned Multiple Access (DAMA) operations are supported also. C- and Ku-band version VSATs are available with a 2.4-meter antenna. Also, a transit-case version is available. A Ku-band version of the mesh VSAT terminal with a 1.8-meter antenna is available in both fixed-site and transit-case versions for additional flexibility.

The mission of the star-VSAT terminal is to serve as user subscriber terminals connected to a VSAT hub-equipped gateway or trunk terminal providing up to eight channels of voice, data, fax, and STU-III access at an aggregate rate of up to 64 kbps. DAMA is supported and both 1.8- and 2.4-meter antennas are available in either C- or Ku-band versions along with transit case versions.

End-To-End SATCOM Service

For those customers who require a SATCOM network for either long- or short-term missions, the CSCI program provides terminals, satellite capacity, tail circuits, and interface/ gateway equipment supporting end-to-end communications. These communications requirements include point-to-point and multipoint-to-multipoint topologies, voice, data, fax, imagery, video services, broadcast, and teleconferencing capabilities.

INTERNATIONAL MARITIME SATELLITE ORGANIZATION

INMARSAT Overview

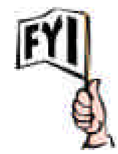
Once an internationally owned satellite consortium, INMARSAT became the first intergovernmental "treaty" organization to privatize and become a limited company. With its headquarters in London, England, INMARSAT comprises over 120 companies that finance the operations and have an investment share.

Originally created to develop and operate a global maritime communications satellite system for distress and other maritime traffic, INMARSAT has expanded significantly to include services to land mobile and aeronautical user terminals. INMARSAT today can be used for disaster relief and emergency communications, and is also widely employed by the media for news reporting from areas where communications would otherwise be difficult or impossible. Services supported by INMARSAT include direct-dial telephone, telex, fax, e-mail, and data connection. For aeronautical applications, automatic position and status reporting and passenger telephones can be added for a variety of communications that can be used while in flight.

INMARSAT consists of four segments: satellite, shore-earth terminals (INMARSAT owned), ship-earth stations (privately owned), and network control. INMARSAT is a four-region system with the orbital locations of the four INMARSAT II and III operational satellites. Coverage is provided over the oceans and most of the land masses around the world. The INMARSAT system operates with small, low-power user terminals communicating in multiplexed fashion with large coastal earth stations that provide interface to the terrestrial switched network.

Army Policy and Use of INMARSAT

The use of the INMARSAT system by the Army has grown tremendously because of its widespread use in global military operations. The ready accessibility and the ease of obtaining service made INMARSAT very popular. The Army is not the only service that has recognized the value of this commercial terminal. The number of Navy ships using INMARSAT increases annually, both by choice and by governmental requirements that ships be equipped with satellite communications. Also, since 1990, INMARSAT has provided



INMARSAT was used in Somalia and Bosnia by Army soldiers in a NATO peacekeeping role to transmit medical data and supply orders.

The INMARSAT organization is very specific about how their system can be used. Army users are restricted from accessing INMARSAT resources except under the limitations prescribed by the INMARSAT organization charter.

Since INMARSAT can be used for administrative, logistical, and other non-aggressive support of combatant forces, INMARSAT is a viable means for tactical logistical communications where availability, cost, and technical factors permit its use.

service to the Air Force fleet as well as ships. Aircraft require more of the satellites' power due to their smaller antenna size and that, in turn, means that the satellite must have increased capacity to service these users. There are now approximately 640 INMARSAT terminals on-hand throughout the Army.

The INMARSAT organization is very specific about how their system can be used. Army users are restricted from accessing INMARSAT resources except under the limitations prescribed by the INMARSAT organization charter. The charter requires that INMARSAT may be used exclusively "for peaceful purposes."

What does that mean? During Operations Desert Shield and Desert Storm, there were many questions concerning how the INMARSAT system could be used and under what conditions before, during, and after the conflict. INMARSAT guidelines established a common interpretation of the "peaceful purposes" clause that addresses the use of INMARSAT by military forces. In summary, the guidelines stated the following:

• INMARSAT may be used by members of the armed forces who are not involved in armed conflict or any threat to breach of the peace.

• INMARSAT may be used by members of the armed forces who are part of a United Nations (UN) peacekeeping or peacemaking force acting under the auspices of the UN to implement UN Security Council decisions in order to maintain or restore international peace and security.

• If not part of a UN peacekeeping force, INMARSAT may be used by members of the military for legitimate individual or collective self-defense when under armed attack.

• Use of INMARSAT by armed forces engaged in armed conflict is permitted for distress and safety communications and for any communications relating to the protection of the wounded, sick, shipwrecked, prisoners of war, and civilians, pursuant to the Geneva Red Cross conventions (1949).

Army policy towards the use of INMARSAT adheres to these guidelines. Additionally, there are further specifics on its use which are under the purview of the Director of Information Systems for Command, Control, Communications, and Computer Spectrum Management Office. INMARSAT use is limited to the following:

• Provision of emergency communications supporting Army roles in disaster relief, search and rescue, support to the Federal Emergency Management Agency, and the public welfare (i.e., humanitarian aid, whether directed to the Army or performed by the Army with Congressional approval).

• Communications in support of peacekeeping missions (i.e., those nationally directed or under U.S. roles supporting forces or actions of the United Nations.

• General purpose communications that are non-aggressive in nature (e.g., administrative, medical, logistical, etc.).

Since INMARSAT can be used for administrative, logistical, and other non-aggressive support of combatant forces, INMARSAT is a viable means for tactical logistical communications where availability, cost, and technical factors permit its use.

Radio regulatory requirements for the INMARSAT system are handled through the office of the Army

Spectrum Manager. U.S. Army Communications-Electronics Services Office (USACESO) coordinates commissioning of Army INMARSAT terminals with COMSAT, a private U.S. corporation designated by law as the U.S. representative to the INMARSAT organization. USACESO is the only designated Army office authorized by Headquarters, Department of the Army to coordinate commissioning directly with the satellite service provider.

Army forces that require INMARSAT communications services must first have a commissioned terminal and receive permission for access. Procedures for obtaining access to INMARSAT terminals and services are contained in Chapter 7, SATCOM Planning, Access, and Control. Additional details on the INMARSAT system can be obtained via the internet at *www.inmarsat.org/index3.html.*

The INMARSAT Satellites

INMARSAT II

The first INMARSAT II satellite was launched in 1990 and there are currently four operational INMARSAT II satellites being used in different locations and capacities. As of September 1999, they were deployed as follows: one primary satellite over the Atlantic Ocean Region-West with one additional satellite as a spare, one satellite located as a spare in the Indian Ocean Region, and one satellite located over the Pacific Ocean Region also as a spare. Each satellite's global beam radiates a footprint which covers approximately one-third of the earth's surface. The design life of these satellites is ten years.

The INMARSAT II satellite is a C-/L-band system, i.e., it uses L-band to the user terminals and C-band to the shore earth stations. It has one C-/L-band l6-MHz channel for shore-to-ship traffic and four C-/L-band channels (two 4.5-MHz, one 7.3-MHz, and one 3.2-MHz bandwidth) for ship-to-shore traffic. Data may be transmitted at 2400 bps (in voice channels), at 64 kbps, or at rates up to l Mbps by specially equipped terminals. The total capacity of one INMARSAT II satellite is equivalent to 250 two-way INMARSAT-A voice circuits.

INMARSAT III

The introduction of a new generation of INMARSAT satellites began with the first launch in May 1996 of an INMARSAT III which is now positioned over the Indian Ocean. There are now five of them in orbit providing communications services to global users located in the Atlantic Ocean Region, Atlantic Ocean Region-East (with two satellites), Indian Ocean Region, and the Pacific Ocean Region. The INMARSAT III uses the latest spot beam technology and higher power to supply voice and data communications to mobile terminals as small as a deck of cards (figure 6-1). Voice channel capacity is up to eight times that of INMARSAT II. The tremendous advantage of the INMARSAT III satellites is their ability to concentrate power on particular areas of high traffic within the footprint. Each satellite utilizes a maximum of seven spot beams and one global coverage beam. The number of spot beams can be adjusted based upon traffic demands.

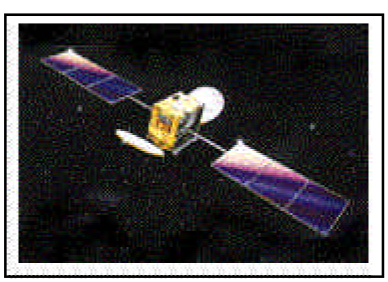


Figure 6-1. INMARSAT III Satellite

FYI

Although it is normal to think of commercial SATCOM technologies as a springboard for military SATCOM to leverage, the reverse is also true. Satellite programs initiated by DoD in the early 1960s produced technologies that were quickly adopted for commercial use starting with INTELSAT in 1965. DoD research and development agencies such as DARPA, continue to produce technologies that can be used by industry as well as government.

INMARSAT Ground Terminals

INMARSAT ground terminals are commercially available from a number of manufacturers. INMARSAT provides interfacing and interoperability specifications to commercial terminal manufacturers who build INMARSAT user earth terminals capable of providing the various standards of voice and data services offered by INMARSAT. A variety of INMARSAT user terminal configurations are available for vehicle mounting, shipboard installations, aircraft applications, and use with other platforms. There are four standard types of terminals that can access INMARSAT. The Army uses INMARSAT terminals in a variety of configurations.

INMARSAT A

There are more than 25,000 INMARSAT-A terminals in operation on land and at sea (figure 6-2). The INMARSAT-A analog mobile SATCOM service provides two-way direct-dial phone, fax, telex, e-mail, and data communications at up to 9.6 kbps. This service typically is full-duplex analog voice transmitted at 9.6 kbps to 56 kbps. The typical Army-owned INMARSAT-A terminal is small, self-contained, and has connections for fax and personal computer in addition to voice. It has a foldaway parabolic antenna that is approximately one meter in diameter. The terminals can work off batteries or portable power supplies. Any transmission from an INMARSAT terminal must go through one of four INMARSAT earth stations located in each region. For a call from a voice terminal, the transmission originates from the user terminal, is uplinked to an INMARSAT satellite in the L-band, and then is downlinked to an INMARSAT fixed-site earth station in the C-band. The earth station can then tie the call into the public switched network which then conveys the call to a commercial phone.

Figure 6-2. INMARSAT A Terminal

Figure 6-3. INMARSAT B Terminal

INMARSAT B

INMARSAT-B service is an advancement over the INMARSAT-A by an improved use of satellite power and bandwidth (figure 6-3). This gives service providers the option to offer users much lower charges while maintaining high quality and reliability in communications. The INMARSAT-B service supports automatic, direct-dial phone, fax, and telex. Data services come in two forms: 64 kbps high speed data and the standard 9.6 kbps service. INMARSAT-B terminals are particularly appealing to high volume users such as the media who use SATCOM for video or broadcast quality audio transmission over high speed data links. Government agencies and peacekeeping forces use an encryption capability on their terminals which allows them to communicate critical information in a secure manner. Current basic cost for an INMARSAT-B terminal is $30,000, with usage charges averaging between $3.60 and $6.00 per minute.

INMARSAT-C

The INMARSAT-C service provides two-way data communications to and from virtually anywhere in the world (figure 6-4). This service provides no voice capability. INMARSAT-C terminals typically are simple, low-cost units which can be hand-carried or vehicularly fitted. Communications using INMARSAT-C service are data or message-based. Anything that can be coded into data bits can be transmitted. The messages are transferred to and from an INMARSAT-C terminal at 600 bps. A typical INMARSAT-C terminal has a small omnidirectional antenna which, because of its light weight and simplicity, can be mounted easily on a vehicle. Directional antennas can also be used for facilities which may not be required to relocate. There are a wide variety of additional features that can be added to the standard messaging service of this terminal. Customers interested in the INMARSAT-C can work directly with the service provider to determine which options can best suit their particular needs.

Figure 6-4. INMARSAT C Terminal

INMARSAT D+

INMARSAT D+ terminals offer two-way data communications utilizing equipment that is no larger than a personal compact disk player. They come with integrated GPS that makes them ideally suited for tracking, tracing, and short data messaging. They also may be used in a broadcast mode. An INMARSAT D+ terminal can store and display up to 40 messages of up to 128 characters each.

INMARSAT Mini-M Phone

The Mini-M Phone was designed to exploit the spot beam power of the Inmarsat-3 satellites. The latest Mini-M's are small, light, and cost effective, weighing about four pounds and resembling a laptop computer in size. Users are typically people who must operate in areas beyond the reach of cellular or fixed communications. Features include a Subscriber Identify Module card that protects the user from fraud because the information stored on it (such as user identity and billing details) is encrypted. Data rate transmission is 2.4 kbps.

INMARSAT M4 Phone

This new satellite phone will increase data transmission rate to 64 kbps. The M4 phone relies on spot beam technology, as does the Mini-M, and will be primarily targeted to users on land.

New services offered by INMARSAT include the **Global Area Network**, which offers e-mail, web/intranet access, image transfer, video conferencing, and e-commerce applications, in addition to voice and fax, allowing users to extend their local area and wide area networks to

The military space-based application of PCS is known as the Mobile Satellite Service.

MSS will be employed by the warfighter as an extension of the existing MILSATCOM architecture and the DISN.

Communicating on the move which is essential to modern mobile warfare, must be immediately available to the warfighting commander and his staff.

remote locations. The network operates using notebook computer-size terminals weighing about 8.8 pounds and costing around $10,000. They are compatible with Ground Support Module cell phones and will be upgradeable.

PERSONAL COMMUNICATIONS SYSTEMS/ MOBILE SATELLITE SYSTEMS

Personal Communications Systems (PCS) are experiencing explosive growth. PCS is primarily commercial wireless cellular telephone technology. The wireless market is rapidly expanding with local area networks, data terminals, and cordless phones. Just as in the personal computer market, PCS devices and services being developed are changing so quickly that it is difficult to know what and when to purchase. While Army is interested in commercial PCS systems because it has requirements to communicate while on the move, and often beyond line of sight, the Army has no funding to develop military mobile communications satellite systems.

The military space-based application of PCS is known as the Mobile Satellite Service (MSS). Because of the unique needs of the warfighter, MSS is an initiative being explored by many commercial firms. The Globalstar constellation has been launched and became operational in 2000. There are many other SATCOM systems under development. The various systems differ in satellite altitudes, method of delivering data streams, and satellite coverage areas.

Army Requirements for MSS

Army requirements for MSS are spelled out in an Army-approved Operational Requirements Document (ORD) dated April 1996. The ORD states that MSS will be employed by the warfighter as an extension of the existing MILSATCOM architecture and the DISN. MSS will provide additional capability for beyond-line-of-sight communications by allowing the off-loading of non-critical voice and data traffic from scarce DoD SATCOM resources. Specifically, interoperability requirements between tactical DoD systems and MSS are defined as follows.

Assured Access

Warfighters need assured access to SATCOM services to exercise positive Command and Control (C2) and for dissemination of critical mission information during all phases of an operation. A warfighter's access to SATCOM must be available on demand for the duration of the mission. This will allow information to be processed rapidly for the warfighter to operate before the enemy can react. Assured access to MSS systems is not applicable only to individual circuits. Obviously, the communications traffic pattern will significantly increase during a crisis situation and MSS must be flexibly responsive to the volume of information that needs to be passed. MSS must NOT become a choke-point.

C4ISR-On-The-Move

Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) is closely tied to assured access. Communicating on the move which is essential to modern mobile warfare, must be immediately available to the warfighting commander and his staff. Voice and data traffic must be transmitted for the commander to quickly get a comprehensive picture of the battlefield in order to obtain a full understanding of ongoing and planned actions. Mobility must not be hindered. If the commander cannot physically carry the communications device with ease, then it must be integrated into the fighting vehicle/ aircraft that he uses. Once deployed, forces must be capable of moving rapidly with their communications.

Hands-Free Operation

Soldiers on the ground must have the freedom and flexibility to move quickly on the battlefield and not be impeded by heavy, cumbersome terminals. Small, lightweight terminals that can be voice-activated would provide an unprecedented level of mobility to the warfighter.

Multi-purpose, Multi-mode, Multi-spectral Terminals

Ground terminals should be capable of interoperating with a variety of military and civilian frequency bands, while supporting different waveforms and modulation schemes. This capability will reduce the amount of equipment that must be deployed and carried by the warfighter who will need to communicate flexibly with or through a diverse number of “digitized” battlefield weapons systems. An interoperable terminal, MSS or DoD, will significantly increase the survivability of the warfighter.

Global Coverage

Warfighters need the capability to access communications support from any worldwide location, including the polar regions. Long range communications via satellite offers a commander rapid access to certain capabilities and information without concern for national boundary and/or political restrictions. It permits a commander to make informed and accurate decisions as well as receive advice and guidance. Experience from past conflicts has shown that the likelihood of U.S. forces being engaged in concurrent, multiple, regional conflicts is high. Warfighters rely on SATCOM systems, including MSS, to support continuous operations worldwide, and to accommodate, simultaneously, widely dispersed forces in various stages of employment, from training to combat.

Required Security Levels of Transmission

The warfighter must have a communications system that can protect the information needed to transmit/ receive at the appropriate level of classification. C2 systems require additional security including anti-jam capability. This is a limitation that must be overcome in the MSS candidate systems and in UHF DoD systems.

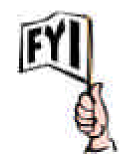
Use of Gateways

Connectivity between mobile users and fixed telephone users, and/or between DoD systems and MSS systems, will require an interface or gateway. DoD application of MSS will involve various combinations of landline telephone users, terrestrial cellular telephone use by mobile users, satellite connectivity, and broadcast capability for remote users.

Variety of Services Required

MSS systems must support the warfighter with a variety of services in all conflict levels. Worldwide, secure and non-secure voice, data, fax, paging, and video-teleconferencing in some selected cases will be required. These services will involve on-the-move users conducting land, air, and sea missions.

Ground terminals should be capable of interoperating with a variety of military and civilian frequency bands, while supporting different waveforms and modulation schemes.



The commercial sector far outpaces DoD in production rates and volumes. For example, the largest military purchase of communications equipment is the SINCGARS radio--75,000 radios were purchased over ten years of production. By contrast, the largest commercial firms are producing land-mobile radios in the range of 400,000 per month. The open, competitive environment spurs this production. There are many competitors! The defense sector has typically been limited to a few (and sometimes just one) contractors.

DoD User-Defined Priorities

Since SATCOM resources, both commercial and DoD, are limited, priorities for access and use must be established, similar to the priority system now imposed by CJCSI 6250.01 on DoD SATCOM resources.

Flexibility

The warfighter needs the ability to adjust supporting MSS and DoD space and terrestrial-based communications capabilities to match the dynamics of the operational environment. This requires flexibility in each segment of the SATCOM system. Satellite repositioning, terminal mobility, frequency selection, and system resource allocation represent different options allowing the user flexibility in responding to rapidly changing operations, threats, and geographic needs. MSS systems are particularly valuable to DoD in certain scenarios (e.g., Satellite Access Request, enroute communications, VIP communications, humanitarian/ disaster relief) but must be flexible enough to allow for rapid reconfiguration should the situation change unexpectedly.

Position/Navigation (POS/NAV)

GPS, in use now, provides an important common frame of reference for situational awareness. GPS should be integrated into any communications system, MSS or DoD, which will be used by the warfighter to improve command, control, and synchronization among all U.S. forces and allies.

These requirements and characteristics as described are not all inclusive. Needs will continue to change and grow, and so will the interoperability requirements for MSS systems.

The small terminal size, flexibility, and mobility that MSS offers to the warfighter is unprecedented. Users of MSS will be able to communicate with small, handheld terminals that can be used for voice or data. The power level needed (about 0.2 watt) is less than that used by a cellular telephone. Key technical features for battlefield use include the following:

- Low transmit levels for encrypted speech, data, video, and mixed speech/data/video/short messages.

- Anti-jam, low probability of interception/low probability of detection, and denial of user location by enemy forces.

- Complete interoperability with all commercial cellular and space-based cellular systems.

- Predefined networks established on demand using two-button dialing.

- No interference from many terminals operating simultaneously in close proximity.

- Position location and reporting information.

- Fully mobile, interconnected base stations with no towers.

To sink large research and development costs into building a satellite network for specific users supporting a specific mission will no longer be necessary to serve Army communications. Using off-the-shelf terminals and leasing transponders on commercial systems, an MSS system for the warfighter can be fielded in days rather than years. Because of the wide variety of commercial systems being developed and launched, competition undoubtably will drive costs down. It is important that the Army signal planners become familiar with the options available in mobile satellite systems, the advantages of each option, and what drawbacks could be encountered.

Orbital Altitudes for MSS

Orbital altitude is key in choosing an MSS system. Low earth orbits (LEOs) are particularly appealing for small, mobile satellite systems because there is less signal loss between the satellite and ground terminals, and less delay in voice transmissions. In fact, the delay inherent in transmissions over a system in LEO is comparible to the delay encountered in a terrestrial transcontinental communications system. This would make an MSS system in LEO a good candidate for military voice, video, and interactive applications such as teleconferencing requirements. ORBCOMM is a LEO satellite system that serves organizations needing to transmit small amounts of data and for whom immediate receipt of that information is not necessarily critical. User organizations include trucking and shipping companies that need to keep track of their vehicles and payloads or get messages to their drivers. Warfighters could use this type of LEO service for tracking supplies, personnel, and other admin/logistical information.

LEO satellites require less power to transmit signals because of their close proximity to earth. This means that LEO satellites cost less, but more satellites are needed for full earth coverage. Maintenance costs for so many satellites are high. The design life of a LEO satellite, being far less than those in higher orbits, average around five to seven years. With the speed of a LEO satellite being greater than that of a satellite in geosynchronous earth orbit a LEO satellite is more susceptible to catastrophic collisions with other orbital space junk.

As they relate to MSS, geosynchronous earth orbit (GEO) satellites cover about one fourth of the earth's surface, so fewer satellites are required for global communications. Because they are at a much higher altitude however, GEO path loss is greater. There is a noticeable delay in communications as the signal travels 70,000 km in addition to processing time. To communicate effectively, GEO satellite transmitter power must be increased significantly and antenna gain at the ground terminals must be greater. Medium Earth Orbits (MEO) are a compromise between LEOs and GEOs. They are at a higher altitude than LEOs but require more power to transmit signals. MEOs are often grouped together with LEOs because of their similarities.

Low earth orbits are particularly appealing for small, mobile satellite systems because there is less signal loss between the satellite and ground terminals, and less delay in voice transmissions.

Which MSS System Meets Your Requirements?

With the plethora of satellite systems being marketed and the willingness of DoD to utilize commercial systems to support warfighter requirements, how is one to choose which MSS service is best? Much depends on the mission and it does make a difference which service is chosen. The CSCI Office (Defense Information Systems Agency) is certainly the best place to start finding answers. Chapter 7 has details on accessing the services of the CSCI Office to obtain commercial SATCOM resources. It is important to have some basic information before beginning the process. The following questions will help in narrowing the choices of service providers and making an informed decision:

—In which countries or world regions can I expect to use a mobile satellite phone?
—Do I want to carry the phone

The DoD had invested heavily in Iridium, a commercial SATCOM system that used small, cellular-like phones and pagers. Unfortunately, after experiencing irreparable financial difficulties and being unable to secure redeeming financial backing, the Iridium owners declared bankruptcy and were compelled in March 2000 to plan an immediate ending of Iridium services, including planning to deorbit the existing Iridium satellites.

IRIDIUM Update

In November 2000, Iridium Satellite LLC of Arnold, Maryland completed acquisition of the bankrupt Iridium LLC's operating assets. The assets include Iridium's global-coverage constellation of low-earth-orbiting satellites and its satellite control network. Iridium Satellite LLC has contracted Boeing Company to operate and maintain the satellite constellation. At the same time, DOD DISA awarded Iridium Satellite LLC a 24-month contract (with extension options through 2007) for unlimited Iridium satellite airtime for 20,000 government users. DISA announced that in 2001, secure communications capability will be made available to already registered DOD Iridium users.

wherever I go, or is it best mounted in a vehicle or field site office?
—Do I need to be contactable and able to make calls when I am mobile?
—Is it okay if my mobile phone only works outside under an open sky and not inside buildings?
—Is fax or data required in addition to voice?
—Is the mobile phone primarily for an emergency or just for regular business use?

There are two commercial telephone satellite systems operational now that offer MSS services: Globalstar and INMARSAT. INMARSAT uses high-orbit geostationary satellites that are stationed 22,900 miles directly above specific locations on the earth's equator. These satellites orbit the earth once every 24 hours. Because the satellite is traveling east and the earth is spinning east, the satellite appears to be stationary relative to earth (even though the satellite is moving faster than a bullet). Globalstar and Iridium use low-earth-orbiting satellites. All three of these systems are further described in the following sections.

Globalstar™

The $3.8 billion Globalstar system is a low-earth-orbiting, satellite-based, wireless, telecommunications system designed to provide MSS services worldwide. Globalstar is focusing on bringing service to people in regions that are underserved or not served at all by cellular and land-line telephone systems. The vast majority of calls made over the Globalstar system are expected to be placed to users within the same nation or region. Although the majority of phones will be mobile units, about 15 percent will be fixed “village” public phones.

Loral Space and Communications, the prime contractor for the Globalstar satellite system has designed and will launch the last dozen of the 52 LEO satellites (including four spares) by the end of 1999, providing redundancy to the system. Forty-eight satellites will be placed into active service with the remainder serving as backup. Globalstar intends to use a phased approach in its service initiation, hopefully avoiding the problems that Iridium encountered when it began global service earlier in 1999.

The first step of this approach began with the aggressive marketing of the Globalstar system in mid-October 1999 at the International Telecommunications Union's Telecom '99 in Geneva, Switzerland, where Globalstar offered free calls. This service continued for one month while Globalstar identified glitches in the system and made changes in routing. One additional positive note that resulted from the testing was a change in the satellite life span to ten years, which is 25 percent longer than originally expected. Globalstar will begin revenue-generating service in North America and Western Europe with nine gateways. Service will be switched on in other regions as Globalstar's partners (who actually retail the service) complete the system's remaining 29 gateways.

The Globalstar system is an example of a service that has enormous potential value to the warfighter because of the myriad mission scenarios that could be supported. The flexibility and mobility of the Globalstar system is ideal for the soldier who already is fully loaded down with life support gear. For the warfighter, Globalstar technology offers increased interoperability because of integration between existing fixed and cellular telephone networks. Globalstar's system employs relatively simple bent-pipe (i.e., transponded) satellites. When a call is placed from a mobile phone, the signal goes directly to a satellite, which downlinks to a regional gateway. The gateway then routes the call through terrestrial lines and, if it is going to another Globalstar phone, the call is sent through another gateway, back up to a satellite, and down to the receiver. This design makes Globalstar dependent upon terrestrial lines, while Iridium can operate completely independently. On the other hand, Globalstar's design allows simpler satellites and much lower operating costs. Globalstar is counting on callers' not caring how their calls are routed as long as they are completed and the quality is good.

Users can place or receive calls using handheld, vehicle-mounted, or fixed terrestrial terminals. Both the handheld and vehicle-mounted terminals resemble today's cellular phones. These terminals will operate in a dual mode, i.e., they can be switched to communicate with either the local fixed or cellular system or through Globalstar satellites, depending upon the availability of cellular coverage in the area. Globalstar's transmission data rate of 9600 bps can support numerous data services (i.e., email and paging) for units equipped with the proper interface appliques. Globalstar employs code division multiple access and the position location services can determine a user's location to within 300 meters.

Additional information on Globalstar, including technical specifications, can be obtained through the corporate website – *www.globalstar.com* or the Globalstar Information Hotline at (408) 933-4000. GlobalstarÔ is a registered trademark of Globalstar Limited Partnership.

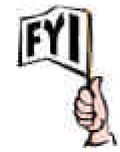
ICO

ICO is a system that is still on the drawing board, but it is well on its way to becoming a reality. ICO integrates mobile satellite communications capability with terrestrial networks. The ICO system will route calls from a terrestrial network through the ICONET - comprising twelve Earth stations or satellite access nodes - and the terrestrial links between them, and then up to a constellation of twelve satellites for delivery to user terminals. Each call from a user terminal will be routed via the satellite constellation and ICONET to the appropriate fixed or mobile network or to another user terminal. Most ICO phones are expected to be dual-mode, working with both the satellite system and terrestrial cellular networks. The ICO system has a high-penetration notification capability designed to deliver a call-attempted alert when the user is inside a building.

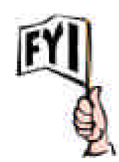
ICO has had financial difficulties. In August 1999, ICO sought protection under Chapter 11 of the U.S. Bankruptcy Code. Since then, however, ICO has revised its business plan and is seeking the remainder of the funding required to complete development of the system. All indications are that ICO will succeed and that the system will be operational sometime in the near future.

Teledesic

Teledesic is a visionary system, still under development, which will be a global, broadband, "Internet in the Sky." It will be a constellation of 288 low-earth-orbiting satellites (plus spares) providing a wide variety of telecommunications services, such as computer networking, broadband Internet access, high-quality voice, and other digital data services. Teledesic is designed to support millions of simultaneous users. Multiple manufacturers will offer a family of user equipment to access the network. Most users will have two-way connections that provide up to 64



Commercial SATCOM providers are not expected to spend a significant amount of resources to harden commercial infrastructures against attacks or to provide total communications security. Encryption design strategies is one area where commercial firms can leverage off of military research and development.



On March 12, 2000, after an apparently successful liftoff, the launch vehicle carrying the first ICO satellite suffered an anomaly and the rocket and its payload were lost over the Pacific Ocean. Although the launch failure is disappointing, ICO recognized the risks and had built extra satellites to guard against such an occurrence. ICO expects no adverse impact on their communications service moving forward as planned.

Teledesic is a visionary system, still under development, which will be a global, broadband, "Internet in the Sky."

GPS is based on the concept of triangulation from known points. The concept is similar to the technique of "resection" used with a map and compass except that it is done by using position and ranging data extracted from radio signals transmitted by satellites.

Mbps on the downlink and up to two Mbps on the uplink. Higher speed terminals will offer 64 Mbps or greater of two-way capacity.

Craig McCaw, Bill Gates, Saudi Prince Alwaleed Bin Talal and Boeing Corporation founded Teledesic in 1990. In 1997, the FCC granted Teledesic its license to operate in the ITU-approved international radio spectrum. The Teledesic system will operate in the Ka-band (28.6 – 29.1 GHz uplink and 18.8 – 19.3 GHz downlink). A major move in 1997 saw Motorola Inc. merge its Celestri program with Teledesic. The move effectively eliminated a potential 72 Celestri satellites and opened the possibility that a large portion of the Motorola's work on the Celestri architecture will be incorporated into Teledesic. Motorola now leads the international industrial team that will develop and deploy the Teledesic Network. In 1999, Lockheed-Martin joined the Teledesic team to provide launching services.

At this point, it is unclear how much the Teledesic architecture will change from the 1997 Federal Communications Commission-approved architecture because of Motorola involvement. In any case, the potential benefit to the warfighter from a system such as Teledesic is enormous. With the envisioned "fiber-like" global access to telecommunications services, soldiers in the field will be able to transmit and receive information quickly, reliably, and responsively in almost any media format required.

Other Potential MSS/PCS Providers

To date, Globalstar has launched and been put into operation satellite communications constellations. Shown at figures 6-5A and B are charts with additional PCS/MSS providers (narrowband and wideband), which have declared potential services that could complement the Army SATCOM architecture. The tables show the technical differences and similarities between the systems as well as the costs and anticipated operational timeframes for service.

GLOBAL POSITIONING SYSTEM

GPS Overview

GPS is a space-based, all-weather, jam-resistant, continuous-operation radio navigation system. The GPS system provides military, civil, and commercial users highly accurate, worldwide, three-dimensional, common-grid, position/location data. It also allows measurement and display of velocity and precision time to accuracies that have not been easily attainable before. GPS is the only system today that can calculate and display a soldier's position on the Earth anytime, in any weather, and at any location to within about 300 feet. Even greater accuracy, usually within less than three feet, can be obtained with corrections calculated by a GPS receiver at a known fixed location.

GPS is based on the concept of triangulation from known points. The concept is similar to the technique of "resection" used with a map and compass except that it is done by using position and ranging data extracted from radio signals transmitted by satellites.

GPS provides a common grid coordinate system based upon the World Geodetic System 1984 (WGS 84). The WGS 84 is similar to the latitude and longitude lines seen on wall maps in schools. The WGS 84 system provides a built-in frame of reference for all military activities whereby units can synchronize their maneu-

Figure 6-5A Emerging Commercial Narrowband Personal Communications Services (PCS) Satellite Systems

	ELLIPSO	***ICO***	***GLOBALSTAR***	***ORBCOMM***	***IRIDIUM***
Major Backers & System Website	HARRIS, LOCKHEED-MARTIN, BOEING (*www.ellipso.com*)	ICO-TELEDESIC GLOBAL LTD. (Craig McCaw) (*www.ico.com*)	LORAL, QUALCOMM, ALCATEL (*www.globalstar.com*)	ORBITAL SCIENCES, TELEGLOBE (*www.orbcomm.com*)	IRIDIUM SATELLITE LLC (*www.iridium.com*)
Use	Voice, Fax, Messaging, Paging, Geolocation	Voice and Messaging	Voice, Data, and Fax ("Big LEO")	Two-way Messaging and Asset Tracking ("Little LEO")	Voice, Data, Fax, and Paging ("Big LEO")
Altitude (miles)	Elliptical MEO & Circular MEO orbits	6459 (MEO orbit)	884 (LEO orbit)	500-600 (LEO orbit)	483 (LEO orbit)
Coverage Area	Global north of 50S	Global	Global between 70N to 70S	Global	Global
Spectrum	UHF band	S and C bands	L, S, and C bands	VHF band	L, K, and Ka bands
Data Throughput	Up to 9.6 kbps	2.4 kbps voice; up to 64 kbps data	Up to 9.6 kbps	57.6 kbps	2.4 kbps
Access Method	CDMA	TDMA	CDMA	Packet, X.400 Addressing	FDMA/TDMA
Intersatellite Communication	No	No	No	No	Yes (K-band)
User Terminal Cost (estimated)	Voice terminals: $1500, fixed station $700, mobile	Voice terminals: $400-$700	Voice terminals: $750	Voice terminals: Starting at $500	Voice terminals: $1000
Operation Starts	2001	2002	November 1999	1995	November 1998
Number of Satellites + Spares	Elliptical MEO: 10 Circular MEO: 7 + replenish by new launches	10 + 2 (Two planes of 5 + 1 at 45 degrees inclination)	48 + 4	35	67 (67 operational as of 20 Aug 1998)

Source: Table was initially adapted from Byte Magazine, Nov 1997

Figure 6-5B Emerging Commercial Wideband Satellite Systems

	CYBERSTAR	ASTROLINK	TELEDESIC	SPACEWAY	SKYBRIDGE
Major Backers & System Website	LORAL with ALCATEL (*www.cyberstar.com*)	LOCKHEED, Telespazio, and TRW (*www.astrolink.com*)	CRAIG McCAW, BILL GATES, MOTOROLA, SAUDI PRINCE ALWALEED BIN TALAL, & BOEING (*www.teledesic.com*)	GM-HUGHES (www.hns.com /spaceway)	ALCATEL with LORAL (*www.skybridge satellite.com*)
Use	Data, Video	Data, Video, Rural Telephony	Voice, Data, Video Conferencing	Data, Multimedia	Voice, Data, Video Conferencing
Altitude (miles)	22,300 (GEO orbit)	22,300 (GEO orbit)	854 (LEO orbits)	22,300 (GEO orbit)	911 (LEO orbits)
Coverage Area	North America, Asia, Europe	Four major-population landmass regions, covered by five orbital locations	Global	Four major- population landmass regions, covered by eight orbital locations	Global between 68N to 68S
Spectrum	Ku (Initial) and Ka bands	Ka band	Ka band	Ka band	Ku band
Antenna Size (estimated)	16 Inches (Initial Ku)	33-47 Inches	10 Inches	As small as 26 Inches	TBD
Data Throughput	400 kbps (Initial Ku); up to 30 Mbps (Ka)	Up to 9.6 Mbps	Broadband terminals: up to 64 Mbps two-way. Most users: up to 64 Mbps downlink & up to 2 Mbps uplink	Up to 6 Mbps	16 kbps-2Mbps to satellite; 16 kbps-60 Mbps to user
Access Method	FDMA, TDMA	FDMA, TDMA	MF-TDMA, TDMA	FDMA, TDMA	CDMA, TDMA, FDMA, WDMA
Intersatellite Communication	Undecided	Yes	Yes	Yes	No
User Terminal Cost (estimated)	$800 (Initial Ku); $1000 (Ka)	Under $1000 to $2500	N/A	Under $1000	$700
Operation Starts	2001	2003	2002	2002	2001
Number of Satellites + Spares	TBD for Ku; 3 likely for Ka	9	288	8 initially	80

Source: Table was initially adapted from Byte Magazine, Nov 1997

vers. The GPS ground receivers contain algorithms needed to convert WGS-84 coordinates into local datums for use with available maps.

Each GPS satellite is equipped with an accurate clock to let it broadcast signals coupled with a precise time message. The ground unit receives the satellite signal, which travels at the speed of light. Even at this speed, the signal takes a measurable amount of time to reach the receiver. The difference between the time the signal is sent and the time it is received, multiplied by the speed of light, enables the receiver to calculate the distance to the satellite. To measure precise latitude, longitude, and altitude, the receiver measures the time it took for the signals from at least four separate satellites to get to the receiver.

The user's GPS receiver must determine precisely when a signal is sent from selected GPS satellites and the time it is received. Only a GPS receiver is needed to use the system so it is immediately available to soldiers as they deploy into any theater of operation. In addition, GPS receivers do not transmit any signals; therefore they are not electronically detectable. Because they only receive signals, there is no limit to the number of simultaneous GPS users. The accuracy of GPS does not degrade over time or distance, as does the accuracy of inertial or Doppler navigation aids.

GPS Background

GPS evolved from several pioneering space-based, two-dimensional navigation systems developed by the United States Air Force and Navy in the 1960s. The initial programs were called the TRANSIT and TIMATION satellite systems. The TRANSIT system, under the control of the Navy, was a space-based navigation system that began operation in 1964. It worked by measuring the Doppler shift of signals sent from the satellite. Another Navy navigation system was called TIMATION. It was intended to provide two-dimensional navigational data. TIMATION began in 1960, about the same time that the Air Force was testing the concept for a three-dimensional navigation system called "621B." There was some concern that TIMATION and 621B were duplicative capabilities. The Air Force was designated as the executive agent to consolidate the two systems into one robust, three-dimensional navigation system that would meet the needs of all services. The result was GPS.

The GPS program began in 1973 with concept validation (Phase I). A series of Block I satellites were launched to test, demonstrate, and refine the GPS concept. The first signals from a satellite were transmitted in June 1977. The first use of multiple satellites to determine a three-dimensional position occurred in December 1978.

Full Scale Development (Phase II) began in July 1979. Contracts were placed for the production and testing of preliminary user equipment designs and the construction of an initial control segment ground station which began operations at Vandenberg AFB, California in 1980. After extensive developmental testing, contracts were placed for fully operational Block II satellites in 1983.

Production (Phase III) began in 1985 when a contract was placed with Rockwell Collins for the production of Phase III user equipment. During this period, improved Block IIA satellites were launched. Work continued on a permanent control segment with the Master Control Station at Schriever AFB, Colorado and four remote transmitter/monitor

Because they only receive signals, there is no limit to the number of simultaneous GPS users.

Desert Storm demonstrated GPS as a practical and successful battlefield navigation system. The desert, with its wide, featureless expanses of sand, had the potential for wartime disaster. The terrain looks much the same for miles.

stations. By the time Operation Desert Storm occurred in 1990, all three segments of GPS had achieved limited operational status and COTS ground terminal equipment, including the Small Lightweight GPS Receiver, was procured for use by warfighters.

Desert Storm demonstrated GPS as a practical and successful battlefield navigation system. The desert, with its wide, featureless expanses of sand, had the potential for wartime disaster. The terrain looks much the same for miles. Without a reliable navigation system, U.S. forces could not have performed the maneuvers of Operation Desert Storm. With GPS, the soldiers were able to go places and maneuver in sandstorms or at night when even the Saudi troops who lived there could not maneuver. Initially, more than 1,000 portable commercial GPS receivers were purchased for U.S. troops' use. The demand was so great that, before the end of the conflict, more than 9,000 commercial receivers were in use in the Gulf region. They were carried by foot soldiers and attached to vehicles, helicopters, and aircraft instrument panels. GPS receivers were used in several aircraft, including F-16 fighters, KC-135 aerial refuelers, and B-2 bombers. Navy ships used the GPS receivers for rendezvous, minesweeping, and aircraft operations.

GPS Segments

The GPS consists of three major segments: space, control, and user segments (figure 6-6). The space segment consists of 24 satellites operating in six circular orbital planes with an inclination of 55 degrees at 10,900 nautical miles altitude. This provides complete global coverage. GPS satellites are positioned so that ground receivers can receive signals from six of them nearly 100 percent of

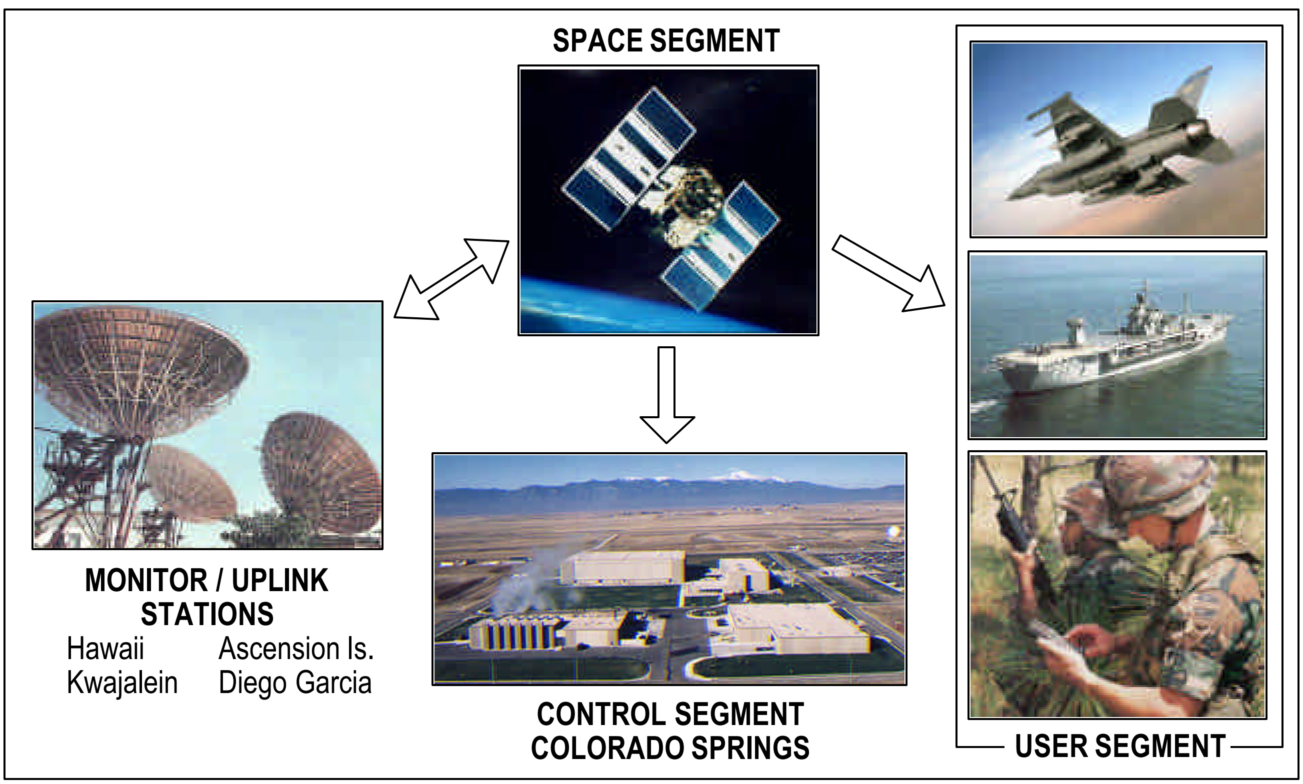


Figure 6-6. GPS System Segments

the time at any point on Earth. That many signals are required to obtain the best and most accurate position information. The satellites are equipped with very precise clocks that keep accurate time to within three nanoseconds – that is 0.000000003, or three billionths of a second. This precision timing is important because the receiver must determine exactly how long it takes for signals to travel from each GPS satellite. The receiver uses this information to calculate its position.

The constellation is maintained by the use of on-orbit spares and the periodic launch of new satellites to replace aging ones. The design life of a typical satellite is seven years but there are some satellites that have continued to function for more than ten years. The current constellation consists of Block IIA and Block IIR satellites. The first launch of the next generation of GPS Block IIF satellites is scheduled for July 2005.

The GPS control segment, operated by the U.S. Air Force Space Command, consists of the GPS Master Control Station (MCS) and a Monitor Station at Schriever Air Force Base, Colorado. Other Monitor Stations are located at Cape Canaveral, Hawaii; Ascension Island, Diego Garcia, and Kwajalein Atoll. Monitor stations track all GPS satellites in view and collect ranging data and satellite clock data passed to the MCS over the Defense Satellite Communications System satellites. Operators in the MCS calculate each satellite's status, ephemeris, and clock data. These data are then sent to transmitting antennas located at the Monitor Stations where the data is uploaded to each satellite for inclusion in the navigation message transmitted by the satellites. This is done to maintain the desired system accuracy. A backup Control Station is planned for Vandenberg Air Force Base, California.

The user segment of GPS consists of all military and civil users, both U.S. and foreign, and the receiver equipment configured for handheld, ground, aircraft, and watercraft applications. The typical hand-held receiver is about the size of a cellular telephone, and the newer models are even smaller. The hand-held units distributed to Army personnel during the Persian Gulf War weighed only 28 ounces. Military GPS receivers are differentiated from commercial GPS receivers by the addition of the Precise Positioning Service (PPS) capability to provide enhanced accuracy and signal protection. Civil user equipment can only access the Standard Positioning Service signal for lesser accuracy than PPS.

How GPS Works

For a ground receiver to determine its own three-dimensional position, it must calculate four unknowns; latitude, longitude, altitude, and time. For this reason, the ground receiver must receive signals from four satellites. Calculation of a two-dimensional position (no altitude) requires three satellites to be in view of the receiver.

A GPS receiver has to acquire and track signals from the GPS satellites, achieve carrier and code tracking, collect data from the navigational message included in the signals, and then make pseudo-range and relative velocity measurements. From this information, the receiver can calculate the GPS time, its position, and its velocity. The results are then displayed on a screen.

The accuracy of GPS receivers is stated in statistical terms. Many GPS receivers can display ten digits in Military Grip Reference System grid

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DoD will continue to maintain and replenish the existing GPS satellite constellation to assure uninterrupted access for both civil and military users.

coordinates which equals to 1-meter resolution. This does not mean that the receiver has one meter accuracy. To get the best possible accuracy, a GPS receiver will select satellites that offer the best geometry. This is the same approach that soldiers use in selecting points on which to sight when using the technique of resection with a map and compass to determine a location. A more accurate answer is obtained by sighting on two or more points that are far apart. This is also true with GPS. Satellites that appear farther apart in the sky provide a more accurate position solution than ones close together. Since the ephemeris of each satellite is known by the GPS receiver, it is possible to calculate which combination of GPS satellites provide the best geometry at a given time. This is translated into a figure called the Position Dilution of Precision (PDOP). Since the satellites move across the sky relative to the user, the PDOP is always changing. A low PDOP is better. A PDOP of four to six is considered good. Position solutions calculated when the PDOP is from six to ten should be used cautiously because they may have significant error. A PDOP that is above ten indicates unacceptable error. Each GPS satellite has atomic clocks on board to maintain accurate time. Data on the status and accuracy of these atomic clocks are sent to the GPS control segment. Corrections are sent to the satellites whenever necessary to keep the system within specification. Atomic clocks are not nuclear powered. They get their name because they use the very stable oscillations of certain elements, often rubidium or cesium, to measure the passage of time. The accuracy is very high (plus or minus one second every 360,000 years).

GPS User Equipment

The development and acquisition of GPS receivers for the military users is managed by the GPS Joint Program Office (JPO) located at Los Angeles Air Force Base, California. The GPS JPO is staffed by personnel from the U.S. Air Force, Army, Navy, Marine Corps, and Coast Guard, along with representatives from the U.S. Defense Mapping Agency, Australia, and many NATO countries. The GPS JPO also provides information to manufacturers of civilian GPS receivers and processors. There are many different types of GPS receivers, each intended to best meet the needs of a specific group of users. The responsiveness and accuracy of GPS receivers is determined by the electronics (hardware) and programs (software) stored in the set. The number of channels in a receiver determines the number of satellites from which it can receive signals simultaneously.

The tables in figures 6-7 and 6-8 summarize the features of many of the GPS receivers found in the Army today and those under development for use by the warfighter in the future.

THE FUTURE OF GPS IN THE ARMY

DoD will continue to maintain and replenish the existing GPS satellite constellation to assure uninterrupted access for both civil and military users. Major initiatives are underway to address system growth and future military needs. These include GPS Modernization and Navigation Warfare enhancements that will prevent hostile use of GPS, while protecting military use of GPS by the U.S. and its allies and preserving the peaceful use of the civil radio navigation service.

GPS – Current User Equipment (UE)	
	**OH & UH** - These are the original Army GPS UE. Developed in the early days of the GPS program, these two-channel receivers are still operating effectively in helicopters and low-dynamic, fixed-wing aircraft. The names are derived from the original target platforms, the UH-60 and OH-58 helicopters.
	**CUGR** - The Cargo Utility GPS Receiver (CUGR) is the second-generation equivalent of the UH. It is targeted at utility aircraft that have a requirement for an integrated GPS product. It is also the first military GPS product to support the use of predefined navigational databases (via PCMCIA memory card).
	**SAGR** - The Standalone Airborne GPS Receiver (SAGR) is intended for non-integrated use in airborne platforms that would not otherwise have a GPS navigation system. SAGR is the Army's answer to the Congressional GPS 2000 mandate.
	**DGNS & EGI** – The Doppler/GPS Navigation System (DGNS) and Embedded GPS Inertial (EGI) system combine GPS with Doppler or inertial technology to provide PPS-capable GPS to the Army's modernized aircraft including the UH-60, AH-64, OH-58D, and CH-47D fleets.
	**3S** - This five-channel unit, part of the original suite of UE, is used in large oceangoing watercraft. Specifically designed for use at sea, it supports several Navy-unique interfaces and has software functions especially tailored to deal with oceangoing dynamics.
	**MAGR** - Originally intended as an airborne receiver, this five-channel unit is utilized in the Army's ground-based EW systems. The Miniature Airborne GPS Receiver (MAGR) is the first of the second generation of GPS UE - smaller & lighter than its predecessor, with increased functionality and field-loadable software.
	**PLGR** - The Precision Lightweight GPS Receiver (PLGR) is currently the Army-wide primary GPS resource. Over 70,000 of these five-channel sets are in use in handheld, mounted, and integrated configurations.
	**GPS-S** - The GPS Survey (GPS-S) system provides highly accurate positioning information for use by Army topographic surveyors. It is also used by the US Marine Corps to survey gun emplacements

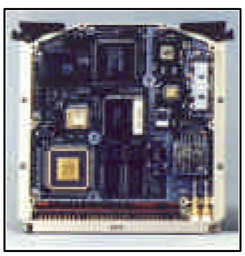
Figure 6-7. Current GPS Receivers are Found in a Variety of DoD Platforms

GPS – Future User Equipment (UE)

(Notional Artist's Conception)

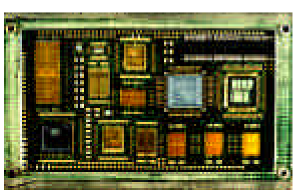
DAGR - Intended as a replacement for PLGR, the Defense Advanced GPS Receiver (DAGR) will provide PLGR functionality, plus new features, in a smaller package. It will be a key element in position reporting for the new electronic battlefield. DAGR will also be the first GPS UE to feature the SAASM security chip in all production units.

GPS/INS - The GPS/Inertial Navigation System (GPS/INS) is a tightly coupled, secure GPS receiver and miniature inertial measurement unit. It will provide a low-cost, synergistic navigation solution to a variety of vehicles.



GRAM - GPS Receiver Application Module (GRAM) is "GPS on a card." With the full functionality of a precision GPS receiver on a standard-bus card, the GPS customer has the ability to embed a standard, approved GPS module into another host application system - saving space & weight. The use of open architecture also allows for future upgrades by simply replacing the GRAM card.

GRAM is actually a family of products, with varying physical configurations and functionality. Current planning calls for a minimum of three configurations: VME bus and SEM-E for avionics applications, and PCMCIA for ground-based vehicle applications. The PCMCIA type is likely to be the one most commonly used for Army customers.



SAASM - Selective Availability and Anti-Spoof Module (SAASM) takes the next logical step after GRAM to put GPS on a single, large chip. By putting the critical navigation and cryptological functions on a tamper-resistant chip, SAASM minimizes the risk of compromise of the critical algorithms and functions that provide maximum accuracy and reduce threats.

All GPS-augmented aircraft navigation systems will be upgraded to incorporate SAASM technology and other capabilities required for compliance with emerging FAA directives that will control flight in national airspace.

CSEL – Combat Survivor Evader Locator (CSEL) is a handheld combination radio and GPS receiver that will report the location of a downed pilot on a secure radio link to recovery forces. The CSEL is the first system to provide downed aircrew members or isolated personnel with a secure, digital, two-way, over-the-horizon communications capability.

Figure 6-8. Future GPS Receivers will be Smaller, more Flexible, and more Secure

Modernization entails improving performance of GPS service for both civil and military use by the addition of new military codes on the L1 and L2 frequencies, addition of a civil code on the L2 frequency, and the addition of a third civilian frequency. This new GPS signal structure will be incorporated in the Block IIR satellites with launches starting in FY03.

All Army GPS receivers will be upgraded or replaced to enable improved performance and better security protection in a hostile Electronic Warfare environment. The modernization effort is anticipated to occur during the FY03-14 timeframe. Three of the new GPS receivers are designated as Horizontal Technology Insertion (HTI) initiatives due to their broad range of applications and need for cooperative financial and technical efforts among Army project managers to integrate them into affected host platforms and weapons systems. The HTI GPS products are the DoD Advanced GPS Receiver, GPS Receiver Application Module, and GPS/Inertial Navigation System.

The GPS system was developed to meet military needs of the DoD, but new ways to use its capabilities are continually being found - often as a result of commercial use. For example, during construction of the tunnel under the English Channel, British and French crews started digging from the opposite ends of the tunnel at Dover, England, and Calais, France. They relied on GPS receivers outside the tunnel to check their positions along the way and to make sure they met exactly in the middle. Otherwise, the tunnel might have been crooked. Army engineers can use GPS for the same type applications.

Vehicle tracking is one of the fastest-growing GPS applications. GPS-equipped fleet vehicles, public transportation systems, delivery trucks, and courier services use receivers to monitor their locations at all times. Army transportation units are using systems with GPS to track logistics packages and the locations of their vehicles.

GPS is also helping to save lives. Many police, fire, and emergency medical service units are using GPS receivers to determine the police car, fire truck, or ambulance nearest to an emergency, enabling the quickest possible response in life-or-death situations. Army medical units can use GPS along with telemedicine applications to save lives on the battlefield.

Commercial mapping and surveying companies use GPS extensively. In the field of wildlife management, endangered species such as Montana elk and Mojave Desert tortoises are being fitted with GPS receivers and tiny transmitters to help determine population distribution patterns and possible sources of disease. GPS-equipped balloons are monitoring holes in the ozone layer over the Polar Regions, and air quality is being monitored using GPS receivers. Buoys tracking major oil spills transmit data that includes GPS data.

There will soon come a time when every Army vehicle, tank, aircraft, and soldier is equipped with a GPS receiver including a video display showing a full situational awareness status. Systems such as these are being tested now. The future of GPS is unlimited. New applications will continue to be created as the technology evolves well into the 21st century.

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The Army has many reasons to use commercial SATCOM whenever possible. The selective use of its products and services can help accommodate the growing SATCOM requirements in spite of declining budgets. Still, there are unique military needs that cannot be met by the commercial sector for a good reason...the motivations and interests of the two sectors are very different!

SUMMARY

Commercial SATCOM is essential for the Army warfighter. The flexibility and responsiveness that it offers is critical for Army communications. Used extensively by the Army now, commercial SATCOM has been tested successfully during recent conflicts around the world. INMARSAT, Alascom, and INTELSAT are a few examples of commercial SATCOM systems that the Army has relied upon for communications in the past and MSS systems such as Iridium™ are rapidly assuming a place in the Army SATCOM architecture. Commercial SATCOM is an alternative means of satisfying those communications requirements that cannot be satisfied using military SATCOM.

The use of commercial SATCOM is evident throughout the Army. The GPS has been integrated into many Army products and is used extensively in contingency missions. Although it is an Army SATCOM ground terminal, the SHF Tri-Band Advanced Range Extension Tactical Terminal (STAR-T) will have the capability to use commercial satellites in the C- and Ku-bands as well as the military X-band. Many other uses for commercial SATCOM are being explored and, where possible, are being integrated into the Army SATCOM architecture.

There are distinct differences between commercial and military SATCOM. High costs associated with commercial SATCOM access and the often difficult necessity of getting host nation approvals are important considerations in the event of a conflict overseas. Commercial SATCOM is not as jam resistant as the military SATCOM systems. Access to commercial SATCOM, however, is usually less difficult than military SATCOM access, barring any host nation approval problems. The Army benefits substantially by letting the international marketplace determine the successes and failures in the global MSS market. With so many comparable systems under development and being launched, the Army does not have to invest in any of them prior to determining which systems can best satisfy requirements.

The visible success of GPS during Desert Storm and the maturing of the system architecture generated broad military and civilian customer interest in GPS. The civil applications of GPS for navigation, tracking and surveying triggered the competitive development of GPS receivers that drove down their cost and size. DoD launched the next generation of satellites (Block IIA) and expanded the family of GPS military users to include over two-dozen Allied nations. On the civil side, commercial applications exploded and the Federal Aviation Agency determined that a GPS-based navigation system would be the foundation for air traffic control in the emerging National Airspace System.

There are benefits and disadvantages that must be traded off between military and commercial SATCOM to provide timely, economical communications appropriate to the mission. The Army cannot satisfy its myriad communications requirements without a proper mix of both commercial and military SATCOM. Each has its place in the Army military satellite communications architecture.

ATM
Asynchronous Transfer Mode

BMC
Bandwidth Management Center

C4ISR
Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance

C4IT
Command, Control, Communications, Computers, Information Technology

CMO
CSCI Management Office

CONUS
Continental United States

COTS
Commercial-Off-The-Shelf

CSCI
Commercial Satellite Communications Initiative

CSTP
Commercial SATCOM Terminal Program

DAMA
Demand Assigned Multiple Access

DISN
Defense Information Systems Network

DOD
Department of Defense

GBS
Global Broadcast Service

GEO
Geosynchronous Earth Orbit

GPS
Global Positioning System

HTI
Horizontal Technology Integration

INMARSAT
International Maritime Satellite

INTELSAT
International Telecommunications Satellite Organization

JPO
Joint Program Office

LEO
Low Earth Orbit

MCS
Master Control Station

MEO
Medium Earth Orbit

MILSATCOM
Military Satellite Communications

MILSPEC
Military Specifications

MSS
Mobile Satellite Service

ORD
Operational Requirements Document

PCS
Personal Communications System

PDOP
Position Dilution of Precision

PPS
Precise Positioning Service

PPT
Post, Telegraph and Telephone

RSSC
Regional Satellite Support Center

SATCOM
Satellite Communications

STAR-T
SHF Tri-Band Advanced Range Extension Tactical Terminal

STU III
Secure Telephone Unit

UHF
Ultra High Frequency

UN
United Nations

USACESO
U.S. Army Communications-Electronics Services Office

VSAT
Very Small Aperture Terminal

WGS84
World Geodetic System 1984